Hon. Mr. Bellerose

NORTH SHORE RAILWAY.

REVIEW

BY THE CHIEF ENGINEER

OF THE

Reports made by the GOVERNMENT ENGINEER

RESPECTING THE CHARACTER OF THE ROAD.

1875.

NORTH SHORE RAILWAY.

REVIEW BY THE CHIEF ENGINEER

OF AN EXTRACT FROM A REPORT MADE BY THE GOVERNMENT ENGINEER, UPON THE CHARACTER OF THE ROAD, UNDER DATE OF NOVEMBER 25, 1874.

OFFICE OF THE ENGINEER IN CHIEF,

Quebec, January 14th, 1874.

MR. SECRETARY,

I have this moment received from you, a certified copy of a Resolution adopted by the Board of Directors at a meeting held this morning, as follows:

"*Resolved*,—That the extracts from Mr. Light's report, placed before the Board, by the Hon. the Commissioner of Public Works, be referred to the Engineer in Chief of the Company, with request to make known to the Directors at their next meeting to-morrow, his opinion on the value of the remarks contained in these extracts."

I had previously been favored, informally, with a copy of this extract, together with an intimation from the President, that I would probably be called upon by the Board, to express an opinion upon the subject; and I had therefore taken measures to obtain such reliable information as might be useful in forming such opinion, and placing it in proper form before the Board of Directors.

Having had a somewhat extended experience in operating Railways, during the winter months, in the United States, particularly through the heart of the Rocky Mountains, during the construction of the Union Pacific Railway; and having located the line, arranged the grades, and prepared the specifications and plans for this Railway, with particular reference to avoiding difficulties from this source, so far as it could be done under the present contract, and with the available means of the Company, I thought it desirable, first, to ascertain from some reliable and practical source, whether my own theory upon this question, as based upon the experience above referred to, could be relied upon, as applying to this climate, and to the circumstances connected with this particular road.

I therefore addressed a letter upon this subject, to Mr. A. L. Smith, of this City, whom I knew to be a very reliable man, as well as a practical Locomotive Engineer, who had had a large experience in meeting and overcoming snow difficulties upon the worst roads in North Western New York; and I also knew him to be entirely familiar with the climate and snow-fall of the country traversed by this road, as well as with the characteristics of the road, so far as they could be affected by this question. I also requested Mr. Smith, to confer with the Locomotive Engineers running upon that portion of the Grand Trunk Railway, between River du Loup and Richmond, and to ascertain whether their experiences coincided with his own.

The following are copies of my letter to Mr. Smith and his reply thereto:

CHIEF ENGINEER TO Mr. A. L. SMITH.

OFFICE OF THE ENGINEER IN CHIEF,

Quebec, January 9, 1875.

DEAR SIR,

As you have had a large experience as Locomotive Engineer, in running upon railroads that are obstructed by snow, during the winter months; and as you are quite familiar with the country, climate and snow-fall between Quebec and Three Rivers, and also with the location of the line and arrangement of grades for this road between these points; I would thank you to give me your views as to the practicability of keeping the road, when completed, open for business during the winter months.

I will also thank you to state whether on a level plain, and through an open country, where the embankment is taken from the sides, you would consider it essential that the top of the rail should be more than two feet above the natural surface of the ground, in order to avoid serious obstructions from snow.

Please state generally the result of your experience, observation, and inquiry with reference to snow obstructions; as to when, and under what circumstances, they are most likely to occur, and the most effective plan for avoiding them.

I would also like your views as to the best width of roadbed, at the base of the cross-tie, having reference to the items of drainage, obstructions from snow, and the safety of the passage of trains over the road.

Also, with reference to comparative safety in case of accidents.

Yours truly,

S. SEYMOUR,

Chief Engineer.

A. L. SMITH, Esq.,
Quebec.

MEMORANDUM FURNISHED MR. SMITH.

1st. What height above the natural surface of ground is it safe to put the track, so that an engine will run through with an ordinary "pilot," and clear the track of snow.

2nd. What depth of cutting (if filled with snow) will an engine go through with an ordinary "snow plough" without getting "stalled."

3rd. What direction does the wind blow when it drifts the snow the worst; and will "snow fences" prevent the snow from drifting on the track.

MR. A. L. SMITH TO THE CHIEF ENGINEER.

Quebec, January 12th, 1875.

GENERAL SEYMOUR,

North Shore Railway Company.

SIR,

In answer to your favor of the 9th instant, requesting me to state my views as to the practicability of keeping the North Shore Railway open for business during the winter months; and in answer to your various queries, I beg to reply, that where the line of road runs through only small cuttings, fences of from six to eight feet in height generally serve as a sufficient protection to keep the track comparatively clear of snow. Where the cuttings are of greater depth and in exposed situations, it will be necessary to erect fences from six to twelve feet high. In answer to your question as to "whether on a level plain and through an open country, where the embankment is taken from the sides, it would be essential that the top of the rail should be more than two feet above the natural surface of the ground, in order to avoid serious obstructions from snow."

I consider that the elevation of two feet is perfectly safe, and that no greater height is necessary; because in all my previous experiences, on both American and Canadian Railways, I have never seen an engine or train stalled when on a level plain or open country, simply from the fact that the snow in such places only falls its natural depth; and it is only in cuttings where the large and obstructive snow drifts accumulate. From the many consultations and conversations that I have had with the practical men of the Grand Trunk and several other Railways, which run through a country precisely similar in climate and character, to the one between Quebec and Three Rivers, I find that their opinions coincide with my own, namely, that the elevation I have already mentioned renders the running of trains and communication perfectly feasible, because the average snow fall in this country is hardly ever more than three feet. Any schemes for the elevation of the rail track above the ordinary snow level, would not only entail enormous expense, but would be quite unnecessary, because any snow plough of the usual dimensions could, without difficulty, throw aside the accumulation of snow when not deeper than stated above.

In answer to the first question, I am of the opinion, as mentioned in the first part of my letter, that a track constructed two feet above natural formation level would meet all the requirements of the case, and afford a clear and uninterrupted passage for engines, provided with such winter pilots, similar to those in use on all North American Lines of Road, during the winter months.

Question No. 2.—What depth of cutting (if filled with snow) will a Locomotive go through with a snow plough (ordinarily) without getting "stalled?" In answering this I presume that ordinary snow-storms are intended; and I believe that in cuttings of three or four hundred feet in length, the Locomotive could make its way through from

four to five feet thick of drift, which height is very rarely exceeded. It sometimes happens that the wind catches up sand as well as snow; and this, when mixed, forms a conglomerate mass that can only be removed by manual appliances, but this is unusual.

Question No. 3.—What direction does the wind blow when it drifts the worst, and will snow fences prevent the snow from drifting on the tracks? I consider that the wind by which snow drifts attain their greatest volume is the North-West wind, but there are frequently severe storms from the North-East and East; these winds that come from a Northern district naturally bring with them a good deal of snow. Fencing will, I believe, efficiently serve all purposes for the protection of the track, although it occasionally happens, when excessive and protracted snow storms take place, that the fencing gets filled up on both sides, and then the rails get blocked in spite of all preventative schemes. Two years ago, I went over nearly every inch of the ground between this City and Port-Neuf, and graded between stations 282 and 530, and do not think it would be possible to improve the grades with a view of avoiding the drifting of snow. Between Pont Rouge and Port-Neuf there are a good many heavy cuttings and embankments which it would be impossible to avoid, so hilly is the country in this district, and in these places, special precautions will have to be taken in the winter season. Although I do not think that snow sheds, such as are in use in some of the mountainous districts, where the cuttings are of extraordinary height, are at all necessary, the difficulty being met with fences of an extra height. My experience on Railways has been essentially and thoroughly practical, whether as regards the running of Locomotives, or the construction and maintenance of road, more especially in locations where the snow question has always involved serious considerations; and I must conclude this letter by expressing my firm conviction that the line of Rail-

way you are constructing between this City and Three Rivers, can be very easily and economically protected against all snow drifts and other obstacles peculiar to a Northern winter; and that this is in a great measure accounted for, by the line of route and location of the road being so carefully chosen.

With respect to your last question asking for my views regarding the proper width of the road-bed at the base of the cross-ties, having reference to the items of drainage, obstruction from snow, and the safety of the passage of trains over the road; also with reference to the comparative safety in case of accidents. I am of opinion that the bed of the road at the base of the cross-ties should not exceed 10 feet, from the fact that it gives quick drainage and does not permit of soakage; for a 4ft. 8½ inch gauge, the bed should be made very full and round in the centre. In a climate such as this, the last remark is peculiarly applicable, because the snow, when thrown from a bed such as mentioned, is inclined to settle away from the track. It has been my experience to find such beds a success, especially in the Spring and Fall. If this bed is any more dangerous to run trains over than wide beds are, it is something that I am quite unaware of, and I give for a reason that upon wide beds the soakage is so much greater that the ties become loosened from their proper bearings, a fact which is dreaded by all engine drivers. Upon the narrow bed nothing of the kind ever occurs. I would, under all circumstances, prefer the 10 feet bed for safety, convenience and economy.

I am, Sir,

Yours faithfully,

(Signed,) A. L. SMITH.

Finding that the views of Mr. Smith coincided entirely with my own; and that these views were confirmed by the

experience of the Grand Trunk Railway Engineers, with whom he had consulted; I next took measures to ascertain definitely the precise characteristics of that portion of this road, situated between the Cities of Quebec and Three Rivers, so far as they should be regarded as influencing this question.

I therefore made a very careful analysis of the profiles of this portion of the line, and obtained the following results:

1. The total distance from Section No. 3, to Section No. 77 inclusive, is 392,300 feet, or $74\frac{3}{10}$ miles.

2. The distance upon which the top of the rail will be 2 feet and over, above the natural surface of the ground, is 291,480 feet, or 75 per cent; being $55\frac{2}{10}$ miles.

3. The distance upon which the top of the rail will be 3 feet and over, above the natural surface of the ground, is 180,050 feet, or 46 per cent, being $34\frac{1}{10}$ miles.

4. The distance upon which the top of the rail will be 4 feet and over, above the natural surface of the ground, is 93,130 feet, or 24 per cent, being $17\frac{6}{10}$ miles.

5. The distance upon which the top of the rail will be between 2 feet above, and two feet below the natural surface of the ground, is 79,890 feet, or 20 per cent, being $15\frac{3}{10}$ miles.

6. The distance upon which the top of the rail will be from 2 to 5 feet below the original surface, is 13,950 feet, or $3\frac{1}{2}$ per cent, being $2\frac{64}{100}$ miles.

7. The distance upon which the top of the rail will be more than 5 feet below the original surface, is 7,000 feet, or .018 per cent, being equal to $1\frac{1}{3}$ miles.

Having obtained the foregoing data, both as to what constitutes snow obstructions; and as to the probable exposure of this road to these obstructions, I feel prepared in some degree, to comply with the instructions contained in the Resolution of the Board, although I can but feel that the time allowed is far too limited for me even to attempt to do the subject justice.

In looking carefully over the extract from Mr. Light's report, I am very happy to find that he gives a substantial approval to the location of the line, the inclination of the grades, the plans of the structures, and the character of the work already done; the latter, however, with two exceptions, viz: "the earth-works constituting the road-bed are insufficient" and the gradients "are laid too low."

Inasmuch as Mr. Light did not see a mile, or even a rod of earth-work that had been completed, either according to the specifications, or the instructions of the Engineer, I do not consider it worth while at the present time, to enter upon a defence of their sufficiency, further than to state generally, that when fully completed according to contract, they will be found quite up to their requirements as exemplified by the best railway experiences in Canada and the United States.

I also desire, to state further that, when fully completed according to the specifications, the excavations and embankments will be of the same width, at *formation level*, as are required by the specifications for the Montreal Northern Colonization Railway; and that the top of the road-bed, when ballasted, will be wider at the base of the cross-tie than upon that road; and wider in proportion to the gauge than upon either the Grand Trunk or Intercolonial Railway.

He speaks of the widths, as measured at intervals between the Race-Course, and half the distance to Three Rivers, being 11, 12 and 13 feet, and from that point west, as being generally 15 feet.

There will be no difference in the widths at formation level, when the grading is completed; and the reason for the present irregularity is, that the work, in many places, has not been carried out to the side stakes.

The spoil banks, or "snow traps," of which he speaks, are all to be removed before the work is accepted.

I have not seen the profiles of the Northern Colonization Railway; but I shall be much mistaken if, upon a fair comparison, it is not found that this line, from Quebec to Montreal, is quite as free as that line, from the liability to obstructions from snow.

Entering now directly upon the question of the gradients being "laid too low," I will submit the following propositions:

1st. That it is impossible, in this climate, and upon the line of this road, to lay these gradients so high that the road will be entirely free from snow obstructions.

2nd. That an Engineer, while arranging his grades with particular reference to the avoidance of these obstructions, must at the same time be influenced to a great extent by his curvature, his maximum grades, and the uniformity of these grades as affecting frequent undulations, which are always very annoying, and quite often very dangerous in operating the road.

3rd. That the Engineer must in all cases adapt his location, profiles, plans and specifications to the conditions of the contract for the construction of the road; and also, to the available means of the Railway Company, so far as any extra work or materials are involved.

Assuming that the above propositions are assented to, and that it is safe to rely upon sound practical experiences as a guide, I think it may be safely assumed also, that everything has been done thus far, that could have been done under the circumstances, to make the North Shore Railway as perfect as possible in all respects; and that the Board of Directors have no reason to doubt, that, with ordinary precautions against snow obstructions, the road, if ever completed, may be successfully operated during every day in the year.

The foregoing analysis of the profiles, taken in connection with the facts contained in Mr. Smith's letter, demonstrate quite conclusively :

1st. That at least 55 miles, or 75 per cent of the distance between Quebec and Three Rivers, which is elevated 2 feet and over above the surface, can be operated successfully without any protection against, or serious detentions from snow.

2nd. That at least 15 additional miles of the distance may be operated in the same manner, if the shallow cuts of 2 feet and less in depth, are protected in the usual manner by snow fences, as provided for in the contract.

3rd. That $2\frac{3}{8}$ miles of the remaining distance, where the cuts are between 2 and 5 feet in depth, may occasionally require extra power to force the train through ; and,

4th. That upon the remaining $1\frac{1}{3}$ miles, where the cuts are over 5 feet in depth, it may be necessary, in extreme cases, to resort to shovelling.

Entertaining as I do, a firm conviction of the truth of the above conclusions, it is unnecessary for me to extend the discussion further, in order to make known to the Directors my opinion on the value of the remarks contained in these extracts from Mr. Light's report, as required by the Resolution.

I am clearly of the opinion that it is the true policy of the Railway Company, as well as of all other parties interested, to complete the road in the best possible manner in accordance with the terms of the present contract ; and then, if circumstances should require it hereafter, any changes may be made by the use of gravel trains, either in the width of excavations and embankments ; or in the elevation of the track, with much greater facility and economy than it would be possible to do at the present time, when the Company has not even the means at command to secure

the right of way for the entire length of the road-bed that it is proposed to construct.

When this time arrives, if it ever shall, the Company will undoubtedly find itself in a much better condition to incur this expense, than it is now prepared to carry out the recommendation of the Government Engineer, by raising the grade bodily from one to three feet, between Quebec and Three Rivers.

The contract and specifications, as well as the profiles of the line, have been before the Board, embracing four and six Government Directors (some of whom are members of the present Government,) during the past three years; and during that time they have undergone the most searching examination and criticism at the hands of some of the most distinguished Engineers in this country and in Europe, all of which was made known to the Government when the "Railway Aid Act" of the last Session was passed; and also, when the original contract was transferred to, and a supplemental contract entered into with the present Contractor.

This supplemental contract was also prepared by a leading member of the Government, who was at the time, and had been since 1871, a member of the Board of Directors; and it was represented by him as embracing all of the items, conditions and safeguards, amounting in cost to several hundred thousand dollars, that the pecuniary condition of the Railway Company had rendered it necessary to omit from the original contract.

And yet it strangely appears, that not until the present moment, when the whole success of the undertaking seems to depend upon the aid which the Government has promised to the Company, it has been discovered that the entire system of *earth-works* is defective.

It would therefore certainly appear, both in justice and equity, that not only the Board of Directors, but the Government, are precluded from going back, either upon the contract, the Contractor, or the Engineer, beyond the date of the "Railway Aid Act," and the date of the Supplemental Contract, in any criticisms that may be made either in the profiles, or dimensions of "Earth-works" as they are specified and provided for in the contract; and inasmuch as the Government Engineer reports distinctly that these works are "substantial and permanent," and "in accordance with the profiles," it is difficult to see why the Government should hesitate in carrying out its agreement with the Company.

I regard it as exceedingly unfortunate, to say the least, that the Government Engineer did not give the Chief Engineer of the road an opportunity of making any explanations to him whatever, before he entered into a wholesale condemnation of this portion of the work. And I shall be very much surprised, if the extravagant statements contained in his report, shall be the means of crippling either the Company or the Contractor, in carrying forward the work to completion, by inducing the Government to with-hold any portion of the aid which it has promised to the enterprise; and upon which the Contractor has relied in good faith to meet his engagements.

Trusting that I may be permitted to supplement this hastily prepared document hereafter, should circumstances seem to require it,

I have the honor to remain,
Mr. Secretary,
Your obed't Serv't,
S. SEYMOUR,
Chief Engineer.

A. H. VERRET, Esq.,
Secretary of the
North Shore Railway Company,
Quebec.

NORTH SHORE RAILWAY.

REVIEW BY THE CHIEF ENGINEER,

OF A REPORT MADE BY THE GOVERNMENT ENGINEER UPON THE CHARACTER OF THE ROAD, UNDER DATE OF JANUARY 12, 1875.

OFFICE OF THE ENGINEER IN CHIEF,

Quebec, January 26, 1875.

MR. PRESIDENT,

I have the honor to acknowledge the receipt, on Saturday, the 23rd instant, of a copy of a further Report made by the Government Engineer, upon the character of this Road, in which is mentioned several objections to the manner in which it is being constructed, in addition to those referred to in the Extract from his original Report, dated November 25, 1874, to which, by order of the Board, I had the honor to submit a reply on the 14th instant.

At the time of preparing the above reply, it was represented to the Board of Directors, and to myself personally, by the Honorable the Commissioner of Public Works for the Province of Quebec, that the extract from the Report of the Government Engineer therein referred to, and then before the Board, contained all the objections made by the Government Engineer to the character of the work, and to the plans of mechanical structures upon this Road; and upon that representation I was directed by the Board to make, and did make, the review of this extract, dated January 14th, 1875.

Upon an examination of the extract, I also found that it contained the following statement: "The question whether the earth-works are substantial and permanent in character *in all respects*, can be answered in the *affirmative* with two exceptions, viz : the earth-works constituting the Road-bed are insufficient, although in accordance with the profiles."—and : " The inclination of the gradients is generally all that can be desired, but they are laid *too low*."

Inasmuch as this statement of the Government Engineer fully confirmed the statement made to myself, and to the Board of Directors by the Honorable Commissioner of Public Works, I proceeded at once, and in good faith, to make such remarks upon the objections raised by the Government Engineer, and contained in that extract, as the facts in the case clearly seemed to justify.

But it subsequently appears, that by some extraordinary oversight, the Government Engineer neglected to mention, in his first report, several far more serious objections, both to the character of the work, and to the plans which had been adopted, than any which had occurred to him during the preparation of that report; which from its date, November 25th, 1874, was written immediately after his personal inspection of the work ; and while every detail thereof must have been fresh in his memory.

Therefore, on the 12th January, 1875, more than six weeks after the date of his first report, he submitted to the Honorable Commissioner of Public Works, another report, which contains five additional "reasons for considering the North Shore Railway not *first class*."

It is quite noticeable, that this last report of the Government Engineer, is dated *two days previously* to the respective dates upon which the Honorable Commissioner of Public Works made the statement to the Board and myself, above referred to ; and also, to the date of my review

of the extract from his first report, and its presentation to the Board of Directors.

It will be noticed also, that in this last report of the Government Engineer, he states that it was written in consequence of a request contained in a letter received by him on the 12th January, from the Hon Commissioner of Public Works.

By some unaccountable delay, this second report of the Government Engineer, did not reach the office of the Railway Company until the 22nd inst.; and it was not placed in my hands for examination, until the evening of the following day, Saturday.

Leaving the Hon. Commissioner of Public Works, and his Engineer, to reconcile this most extraordinary confusion in dates; and waiving for the present, all personal considerations, I will proceed, as briefly as possible, to review, in the order named by the Government Engineer, his, "reasons for considering the North Shore Railway *not first class*," as stated in his last report.

"*First.*—As most important, the Road-bed between Quebec and Three Rivers is laid entirely too low and narrow, to be continuously and economically worked in this climate."

Reply.—The fallacy of this objection, which is merely a repetition from his first report, is fully shown in my former reply; and therefore will not be noticed further here except to remark in passing, that the fact of his stating that it is the *most important* objection, is of itself, sufficient evidence to my own mind, that he is not entirely familiar with the subject upon which he is writing.

It is a self-evident proposition, that the *Road-bed* can be increased, both in width and height, if necessary, with perhaps greater facility and less expense, after the road shall

have been fully completed and in operation, than it can now be done. While it is equally self-evident, that *not one* of the remaining five objections, can ever be rectified after the road is completed.

I will also quote the following extracts from a letter which I had the honor to submit to the President of the Company upon this subject, dated June 5, 1873, as showing the views which I then entertained, and still entertain, upon the subject of the *width of earth-works*:

"The question as to the proper width of earth-works upon a Railway, is one upon which Engineers never have, and probably will never fully agree. All will admit, however, that the chief requirements of a road-bed, whether it be upon an embankment, in an excavation, upon a structure of masonry, or upon a bridge superstructure, are, that it affords a safe and reliable foundation for the permanent way or track of the Railway, and an unobstructed passage for the trains. And, that in earth-works these conditions should be attained with a due regard to drainage and the stability of the slopes.

"My own experience and observation have satisfied me that a width of twelve feet at the grade line, upon embankments of moderate height, and composed of good material, is quite ample for the foundation required to support the ties, eight feet in length, which sustain all the weight of the engine and train as it passes; and that any greater width is not only surplusage, but actually injurious to the proper drainage and stability of the track. And I know that many first-class roads, in the United States, have been, and are now being built upon this plan; and that in some cases the width has been reduced to eleven feet.

"There was another important consideration, however, which had very great weight in my own mind, not only in the location of the line, and in the establishment of the

gradients; but also, in regulating the widths, at formation level, of excavations and embankments, which was, *the liability of serious obstruction from snow.* And in my opinion this should be a paramount consideration upon a Railway located in this portion of Canada, which must be operated from four to five months in each year, with a large body of snow upon the ground.

"There can be no doubt that the track and roadway can be cleared of this snow with much greater facility, upon a narrow, than it could upon a wider road-bed."

It may not be improper also to quote the opinion of the eminent Engineering House in London, England,—"Sir Charles Fox & Sons," which is also referred to in the same letter, respecting the *snow difficulty:*

"The location of the Main Line appears to have been carefully studied, and the gradients are so arranged as to avoid cuttings as far as possble, a matter of the greatest importance in Canada, to prevent heavy drifting of snow in the winter."

"*Second.*—The culverts or water-ways are built upon imperfect plans," &c.

Reply.—I claim that the Government Engineer could not have examined the manner in which any one culvert or water-way has been constructed upon this road, with sufficient care to enable him to form an intelligent opinion as to its strength or permanency.

The following letter from Mr. Lindsay, Resident Engineer, will, I think, fully bear me out in this statement:

ENGINEER DEPARTMENT OF THE NORTH SHORE RAILWAY.

Quebec, January 23rd, 1875.

GENL. S. SEYMOUR,
Chief Engineer.

DEAR SIR,

As requested, I now give details of the manner in which the culverts constructed on the 1st Residency so far have been built. The foundation pits were dug three feet below bed of stream, under the main body of culverts, and four feet under the end walls; then a flagging course of large flat stones, from a foot to eighteen inches thick, well bedded, laid in the bottom. The walls then built on this flagging course, the end walls being started a foot lower, sometimes at both ends, and sometimes only the lower end, a foot of good sound paving stones is put in between the walls and extend some distance beyond the ends of the culverts.

The walls are built 2f. 6in. thick in all culverts not exceeding 3f. vertical opening, when higher, they are proportionably increased in thickness. The covering is of good sound stones, over-lapping the walls at least half their thickness.

The coping has been put on only one or two as yet. The above relates to culverts built dry of which there are seven nearly completed, and one about one-third finished.

Of culverts in cement there is but one built, all but coping, a very substantial structure, a 7f. by 5ft. box, walls 3f. 6 inches thick on a solid stone foundation, this is laid throughout in cement, is in a deep ravine on a skew.

The streams where the above mentioned dry box culverts are built, are quite small and almost dry in summer, an apron wall can always be put down at the outlet of any of these structures, if found necessary to prevent scouring after the next spring freshet.

I consider 3 feet to be quite ample depth to put foundations down for small culverts in this part of the country, where the early snow falls, prevent the frost from penetrating to that depth.

Herewith I send plans of each kind of culvert as designed similar to those on the Intercolonial Railway.

Yours truly,
(Signed,) JOHN LINDSAY,
Resid't Engineer.

I have constructed innumerable works of this kind upon the same plans during the last thirty years, in every variety of climate; and I challenge any one to point out a single structure that has ever failed in any particular.

"*Third.*—The masonry in the Bridging, although apparently good of its kind, is generally too small, the piers especially. Those intended to carry a span of 160 feet, are but 5 feet thick, or fifty per cent too thin to bear the great vibration caused by the trains running at high velocities, over the large spans. The only pier as yet completed, viz, that on the west side of the Jacques-Cartier River, designed for two spans, or 300 feet of superstructure, is but 4 feet 6 inches thick at under side of coping. This pier is founded on rock, which from its want of elasticity, like the stone sleepers on the old Railways, will augment the shattering effects of passing trains, that will surely wreck it sooner or later; especially as there are no through stone (with the exception of the coping), passing from side to side in the body of the work; and the cementing matter used in its construction is very weak. The usual thickness of piers, in similar situations, on well constructed works, is not less than seven feet thick?"

Reply.—I have taken the pains to copy this objection entire, for the purpose of noticing the inaccuracy of many of the statements which it contains; as well as the fallacy of the conclusions at which it arrives.

1*st*. As to *inaccuracies*.—The piers which are "intended to carry 160 feet spans of bridge superstructure," are *not* "but 5 feet thick." I admit that they were originally drawn to 5 feet upon the plans; but, contrary to my own judgment, I changed the plans at the Portneuf and St. Maurice Rivers, from 5 to 6 feet in thickness, some weeks prior to the date of the Government Engineer's last report, upon the representation of a member of the Government, that the Engineer had advised it; and also, from an intimation from the Contractor, through his Engineer, that he preferred it.

I would have been most happy to have informed the Government Engineer of the change, if he had given me an opportunity of doing so.

The length of bridge superstructure resting on the pier at the Jacques-Cartier River, is *not* "300 feet," as implied by the Government Engineer, unless he can demonstrate that a connecting pier between two spans, sustains the weight of both trusses throughout their entire length.

The cementing matter is *not* "very weak" as stated by the Government Engineer. On the contrary, I know from frequent tests applied to it personally, during its construction, that it is exceedingly strong and adhesive.

The following letters from the Resident and Assistant Engineers, are also offered in evidence:

Quebec, January 2nd, 1875.

GENL. S. SEYMOUR,
Chief Engineer.

DEAR SIR,

In reply to your communication, requesting information relative to the Hydraulic Cement used in the structures upon my residency, I beg leave to say, that the cements used are those known as "Gauvreau's Cement," and the "Island

of Orleans Company's Cement." The former was extensively used on the Intercolonial Railway on the first 100 miles, the latter was also used to some extent, and wherever used, were subjected to severe tests. All cement used on the 1st Residency of the North Shore Railway was tested frequently by myself, my Assistants and Inspectors, and the conclusion come to, was that it was perfectly reliable at 1½ sand to 1 cement, which proportions were consequently adopted, altho' much of it would have stood 2 sand to 1 cement.

Its subsequent appearance shows good adhesive qualities, as very little wash has taken place, and it has set perfectly solid and strong.

I enclose a certificate from Mr. Temple, Assistant Engineer on 2nd Sub-division, and will endeavor to procure others from the late Inspectors of masonry, as soon as I can find their addresses.

Yours truly,

(Signed,) JOHN LINDSAY,
Resident Engineer.

Quebec, 2nd January, 1875.

JOHN LINDSAY, Esq.,
Resident Engineer,
N. S. Railway,
Quebec.

DEAR SIR,

The cement mortar used in the Pier and abutment for the Jacques Cartier Bridge was from the Island of Orleans Company, and was mixed in the proportions of 1-½ sand to 1 cement.

It was tested by yourself at the commencement of operations, and I had the specimen at my boarding-house for some time. It set perfectly hard.

The masonry set firm, and the joints of the Pier look solid with no appearance of wash.

I remain,
Yours truly,
(Signed,) E. B. TEMPLE,
Assistant Engineer.

If the Government Engineer desires to contest this point farther, and in a practical way, I will agree to have the pier taken down to any extent he chooses, if he will agree to pay the expense of rebuilding it, in case his statement is not confirmed.

"The usual thickness of piers in similar situations on well constructed Roads," *is less than 7 feet*, instead of "not less than 7 feet" as stated by the Government Engineer.

There are several bridges now standing in perfect condition, upon the Erie Railway, which I constructed more than twenty years ago, in much more exposed situations, and of much longer spans, than the Jacques Cartier bridge, where the piers are *less than five feet thick* under the coping. If the Government Engineer desires to contest this point, in a practical way, I will agree to send any reliable man that he may name, to measure the thickness of the piers (in similar situations) under the bridges of as many of the first-class Railways in the United States as we may agree upon; provided he will pay the expenses, in case his statement is not confirmed.

2nd. As to *fallacies*.—The Jacques Cartier pier, of which the Government Engineer makes an example, is the thinnest one upon the road, and contains 103½ superficial feet of bearing surface under the coping. According to the usual methods of computation, and allowances for safety, it will sustain 5,692 tons of useful load. The greatest weight that can ever come upon it, including the weight of the bridge super-

structure, and assuming the bridge to be loaded with locomotive engines throughout its entire length, is 238 tons ; which shows that the pier is capable of sustaining *with perfect safety*, 24 times any weight that can ever come upon it.

With reference to the "*great vibration* caused by trains running at high velocities over these large spans," upon which the Government Engineer seems to base his entire argument, I will remark, that trains are never allowed to run at "high velocities" over structures of this kind ; not however as a means of avoiding the *great danger* of which he speaks ; but as a means of safety from accidents, either to the train, or to the superstructure of the bridge while the train is passing.

The Jacques Cartier Bridge is composed of two trusses extending from massive abutments upon either bank, and resting in the center, or nearly so, upon the pier in question. I would therefore be pleased to see the questions demonstrated, either *practically* or *scientifically*, by the Government Engineer : 1st As to how much *vibratory motion* this pier will endure with safety ; and 2nd, as to how much it can ever be made to vibrate from its normal position, by the passage of trains over it at the "highest velocities" that he would authorize, if he were operating the road.

I maintain that masonry, if well constructed, of good materials, can never be affected injuriously, from this cause, under a wooden bridge superstructure. There is a liability, however, to a lateral strain upon the masonry which supports an iron superstructure, caused by the contraction and expansion of the metal ; which is effectually guarded against by placing rollers under the ends of the trusses.

I would therefore suggest to the Government Engineer, that his objection may be obviated, either in this manner,

or perhaps by placing a thick bed of India Rubber or Gutta Percha upon the present bearing surface of the masonry, at very much less expense to the Contractor, than by increasing the thickness of the pier to seven feet.

I maintain also, that *thin* masonry is quite sure to be of much greater relative strength than *thick* masonry, for the reason that it can always be much more firmly bound together; I also maintain, that it is the duty of the Engineer to keep his plans within the lowest limits of entire safety; as well on account of economy in construction, as the permanency and stability of the work.

The masonry in question, although not composed entirely of "through stone," is so thoroughly bound together by the *inter-locking* or *over-lapping* of the different courses, that I consider it to be quite equal, both in horizontal and vertical strength, to what it would be if constructed of "through stone."

The objection raised by the Government Engineer to the *rock foundation* which underlies this pier, is so novel in its character; and is sprung upon me so unexpectedly, at this late day, that I shall not even attempt to answer it.

It would of course be superfluous for me to offer the Government Engineer any assistance in the *scientific* solution of the problems heretofore referred to, with reference to vibratory motion, and its effects either upon the particular pier under consideration, or upon masonry of this kind generally; but I will venture to refer him to a case which affords a very satisfactory *practical* solution of the problem.

It will probably be admitted that the Railway Suspension Bridge at Niagara Falls, affords as good an example of extreme exposure to the influences of *vibratory motion*, as any other that can be named.

This Bridge is composed of a single span of 821½ feet in length, measured from center to center of piers. There are two square stone piers at each end of the bridge, each one of which supports one-fourth of the entire superstructure, and also of any load, or tensile strain that can ever come upon it. These piers are each founded upon *solid rock*; and are each 78½ feet high, above the bottom of the Bridge; and they are each *eight feet square at the top.*

This Bridge has been in constant use since 1853, or during the past twenty years, and, so far as I am informed, it is now as perfect in all its parts, as it was when the first locomotive engine and train of cars passed over it.

From the above data we are enabled to deduce the following mathematical expressions: 8 x 8 x 4=256; therefore, if 256 feet of bearing surface will successfully sustain the weight of the Niagara Railway Suspension Bridge of 821½ feet span, and all the weight that comes upon it, together with the "*augmented shattering effect of passing trains*," due to the fact of its being a *flexible suspension*, instead of a *rigid truss bridge*, how long will the Jacques-Cartier pier, with 103½ feet of bearing surface, and having 158⅝ feet in length of *truss bridge* to sustain, successfully fill the same requirements.

I will leave the Government Engineer to solve the problem, and to profit by the result, as I have neither time nor inclination to follow this branch of the subject further.

"*Fourth.*—The proposed plan of founding piers on soft bottoms in the deep waters of the large rivers, which in some instances are 25 feet deep at low water, although economical, I consider hazardous, &c."

Reply.—The Government Engineer has, in the objection above stated, for the first time raised a question which I consider at all reasonable or debatable; and I shall therefore endeavor to answer it as fully as possible.

The Specifications provide that;

"Whenever solid rock is not found, the foundations will consist, either of paving, concrete, piling, or platforms of timber and plank, as the Engineer may direct.—The whole to be protected by sheet piling, rip-rap, crib-work, or coffer-dams when necessary; and executed in the most thorough and substantial manner."

When the Chicago Contracting Company made the first proposition, and negotiated the present contract for constructing the road, the parties, all of whom were practical railway men, were particular to inquire respecting the kind of sub-structure that would be required for the masonry of the bridges over the many large streams, which the profiles then exhibited to them, showed were to be crossed by the Railway; and I informed them that, so far as I could then judge, from a somewhat superficial examination of these streams, the foundations would be of the same character as those which I had previously adopted for a Railway bridge of a mile in length, across the Potomac River, at Washington, U. S.; which, as they very well knew, were composed of piles, driven in 30 feet water, and protected by cribs filled with stone; and had then stood the severe tests of high floods and ice-jams of the Potomac River, during a period of ten years.

If the above assurance had not been made by me, I do not think that the contract would have been closed upon its present terms; although the specifications, as quoted above, which I afterwards prepared, were fully approved by the Chicago Contracting Company, and were allowed to form part of the contract.

I am not aware that the present Contractor, when he assumed the contract about one year ago, had any knowledge of the above facts. And I do not even know whether they will be regarded, by any one but myself, as having a material bearing upon the present question.

I will freely admit that the plans objected to by the Government Engineer, are to a certain extent an innovation upon the old stereotyped plans in use for such purposes; and therefore, that they are liable to the severest criticisms from a peculiar class of the Engineering profession, who never like to depart from old customs. I have therefore taken great pains to satisfy myself fully as to their safety, as well as their adaptability to the purposes for which they are intended upon this road. And I have also taken suggestions from several practical Contractors, as well as from many sound practical Engineers, with reference to such changes in my original plans, as would tend to increase their safety and facilitate their construction.

I have therefore come to regard the perfected plans as being entirely unobjectionable, provided the specifications and directions of the Engineer and Inspector are adhered to in every particular by the Contractor, during their construction.

I had the honor of addressing a communication to the President and Directors, on the 16th July, 1874, in which the following paragraph occurs :

" To illustrate this principle, I will refer briefly to but a single instance of the many which must necessarily occur during the progress of the work.

" The plans which I have designed for the sub-structure or foundations in deep water, required for the masonry in the bridges which are to span several of the large Rivers, which the line of Railway crosses, are peculiarly my own, and are much cheaper than the ordinary stereotyped plans in use for such purposes. But in order to render them perfectly safe and permanent, the greatest care and attention must be exercised in carrying out every detail of the plan in the execution of the work. If the power to see that this is done, through the agency of Engineers and Inspec-

tors of my own selection, and in whom I have the most entire confidence, is taken from me, I hold that I cannot justly be held responsible for the success of the plan. The failure to drive one single pile to the required depth, or to place one single bolt in the right position, might endanger the safety of the entire structure, which, although, it might stand until after the Railway Company had accepted the road from the Contractor, would be liable to be undermined, and destroyed during the very next freshet that might occur."

It is quite evident to my mind, however, that the Government Engineer, judging from his remark that "should the surrounding crib settle the pier would be destroyed," does not understand, either the theory of the plan, or its practical adaptation.

I take the liberty of quoting the following extract from a Report recently made to the City Council of Quebec, by Mr. Charles Baillargé, City Engineer, as showing his opinion of these foundations :

"Persons unacquainted with Bridge building on a mud bottom, may not have confidence in this system of founding piers of stone masonry on what they may consider such a perishable material as wood; but it is well known that wood, which is altogether and at all times completely under water, is imperishable, logs having been recovered from under water in Europe, which were known to be more than 800 years old, in a perfect state of preservation. Again, as to solidity and stability, I may say that hundreds of the most important and heaviest works in Europe and the United States of America are founded, in some cases, on wooden piles, driven into the bed of Rivers, Estuaries, &c., &., as is now being done at Batiscan and Ste. Annes."

The following extract, from my letter to the President of June 5th, 1873, before referred to, will show the opinion of "Sir Charles Fox and Sons" upon the same subject :

"We have examined the details of the River Bridges, and having been informed by General Seymour, as to the nature of the foundations, and the extent and power of the ice-drifts in the several Rivers, we are satisfied with the designs, and consider them well adapted to their purpose."

I am not at all sensative upon the question of these foundations; and if the Board shall conclude, upon a full investigation of the subject, that any other plan, which shall come within the requirements of the general specifications attached to the contract, is preferable, I see no reason why such plan should not now be adopted for all the rivers, except the St. Anne's, where the work upon the present plan has advanced to such an extent that it could probably not be changed, without incurring a claim for damages, on the part of the contractor.

"*Fifth.*—The superstructure of many of these bridges, especially from Quebec to Portneuf, is much longer than the water way of the streams require," &c. Also, "the same objection applies to trestle work, on which a portion of the railway is to be laid."

Reply.—The spans of the bridges above referred to except the Aux Pommes, Lachevrotiere and Champlain, which are still under advisement, have been decided upon, after a careful study, and personal observation of the streams and their sources, during a period of four consecutive years. Whereas, the Government Engineer has never to my knowledge, passed through the country *but once*; and then over a considerable portion of the distance, between Quebec and Cap Rouge, in a *driving snow storm*; and on the following day, the remainder of the distance to Portneuf, when the ground was *covered with snow*.

In some cases, it has been found necessary to bridge the slopes of the adjoining banks, as well as the streams, in order to obtain secure foundations; but in no case would I

consider it safe, to reduce the clear opening required for the passage of the water.

In cases of this kind, I have always acted upon the two principles:

1st. That we have never yet experienced the highest floods; and,

2nd. "That, when in doubt, the decision should always be upon the side of safety."

The entire question of Trestle work is still in abeyance.

"*Sixth.*—The cement and sand being used at Portneuf Bridge—were very indifferent—the latter indeed, quite unfit for the work, as I pointed out to the resident Engineer."

Reply.—The above objection being the last in the series, and also, as appears from his report, the only one which the Government Engineer "pointed out to the Resident Engineer" who accompanied him over the line on his tour of inspection, I will only state in reply, that the Inspector of the work, Mr. A. Trepanier, whose especial duty it was to pay the closest attention to all important matters of this kind, and whose later experience in such matters has been upon the Intercolonial Railway, shall, if within call, be invited at once to furnish a full and satisfactory reply to the objection raised by the Government Engineer.

Having thus noticed and answered all of the objections made by the Government Engineer, I will conclude what I have now to say, with the following remarks:

1st. In considering this whole subject, so far as any decision is to be influenced by the rough and unfinished condition of the work, at the time of its inspection by the Government Engineer, it should be borne in mind, that the contract, being for a "lump sum," as it is called, the Contractor cannot consistently be required to perform any par-

ticular portion of his work, at any specified time; provided the *entire work* is completed in the manner and within the time specified in the contract; and, therefore, the Engineer can only endeavor to see, that when the work is done, it is properly done.

2nd. If the requirements of the Government, through their present Engineer, respecting the changes that *must* be made in the present specifications, grades, earth-works, masonry, foundations, &c., including the location of the line within and near the City of Quebec, which he has still more recently recommended, are insisted upon, I do not hesitate to say, that either the Railway Company, or the Contractor, or both, as may be decided hereafter, may as well provide immediately for, from a half million, to a million dollars, over and above what has been heretofore anticipated, in order to meet these requirements.

3rd. Having now been connected with this Road during the past four years; and having, during that period, devoted my entire time, and the best energies of my body and mind: 1st, In an effort to induce responsible parties to undertake its construction, upon such terms and conditions as the Company were prepared to offer: 2d. In an effort to place these parties, by the negotiation of their securities, in a condition to commence and carry on the work; and, 3d. In an effort to have the work properly constructed when it was commenced, it may very well be imagined with what feelings I regard the present condition of things, as affecting the final success of the enterprise.

4th. Having devoted a somewhat long and varied professional life, to the construction and management of some of the most difficult and important public works upon the American Continent; among which may be named the Erie, and the Union Pacific Railways; and having constructed upon the former, the Portage Bridge, of 234 feet

in height; and upon the latter, the Dale Creek Bridge of 134 feet; all of which are now standing evidences either of my possessing, or not possessing the amount of professional skill required to construct the North Shore Railway upon proper principles; I think it should be regarded as quite improbable, that I would willingly consent to risk my professional reputation, which is my only dependence in life, either by the construction of this important work upon defective plans; or by failing to do my whole duty to the Railway Company, which has honored me with its confidence.

It would also seem to be equally improbable that, after having filled the most important Engineering positions in the General and State Governments of the United States, I should, at this late day in my professional life, require to be taught the first principles of my profession.

Respectfully submitted,

S. SEYMOUR,
Chief Engineer.

TO THE PRESIDENT AND DIRECTORS.